Editorial

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Precision Spine Care: A New Era of Discovery, Innovation, and Global Impact

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Currently, government resources and initiatives, such as the White House Precision/Personalized Medicine platform and large-scale biobank cohorts located in Asia, Europe, and the United States focusing on big data biometrics (eg, genetics, blood biomarkers, imaging, tissue, and clinical profiles) have declared the urgent need for more precise medical care on an unprecedented level to improve health care utilization and patient outcomes. As such, we have now entered an era of "precision" medical care. However, such a platform has largely focused on cardiovascular disease, diabetes or cancer whereby targeted therapeutic drugs based on patient profiling and genetic variation have dramatically improved patient outcomes and led to more cost-effectiveness.[1] Although such platforms have seen substantial success, the health care community has to date overlooked the more debilitating disorders of the musculoskeletal system, in particular as they relate to the spine.

According to the recent Global Burden of Disease Study, low back pain (LBP) is the world's most disabling condition, affecting every population worldwide.[2] Individuals with LBP have noted decreased daily function, diminished quality of life, work disability, and psychological distress.[3] Studies have even noted that individuals with chronic LBP have significant loss of brain tissue that can affect cognitive function.[4] Such pain is associated with tremendous socioeconomic and health-care consequences. Indirect and direct costs related to the treatment of LBP are estimated to be approximately US$90 billion per year in the United States with similar adjusted rates in other countries worldwide.[5] Nonetheless, proper diagnosis of LBP and identification of pain mechanisms are questionable, outcomes of LBP treatments are often tenuous and have been criticized, and prognostication potential of various pain and disability dimensions as well as management options have limitations. As a result, such limitations have led to increased health care costs to the patient and medical provider with often unsatisfactory patient outcomes. In fact, spine specialists have been often challenged by the popular press, patients, and insurance providers globally because of their frequently poor outcomes in treating patients with LBP. Importantly, although numerous generalized protocols/algorithms and guidelines for the treatment of LBP have been proposed, these often fail to account for more "personalized" or "precise" patient variation with regards to lifestyle, occupation, underlining systemic conditions (eg, patient psychological profile, blood chemistry/inflammatory biomarkers, genetics, etc), patterns of imaging findings and other biometrics that have tremendous potential in the management of LBP.[6,7] For example, we now know that specific pain genes may predict outcomes following treatments for various spine disorders, and that such genetic make-up provides further insight into pain intensity and disability.[8] Such systemic conditions and others have been found to assist in identifying subtypes of pain that may be more amenable to various treatments, understanding patients' pain thresholds and perceptions, predicting outcomes, and further identifying specific pain generators to assist in more tailor-made or "precise" treatments.[9] In fact, the same applies for other spine conditions, whose occurrence, diagnosis, treatments, and outcomes remain uncertain. For example, disc degeneration is a common condition that affects individuals in every population.[10] It still remains speculative why an individual develops disc degeneration and overall different patterns of spinal changes. Nonetheless, it has been a long-held belief that severe disc changes may lead to pain in the low back or in the neck.[11] However, not everyone who has disc degeneration is painful and not every individual who has neck pain or LBP has severe disc changes.[12] Moreover, it remains a mystery as to who may progress to more severe forms of disc degeneration or who may develop disc herniations and resolution of such conditions. Regenerative therapies to treat disc degeneration have taken center stage in the past decade. However, outcomes in human subjects have remained short from stellar with often unsatisfactory results. It remains unknown as to which patients may benefit from such therapy and/or predict their outcomes with some certainty.[13] In fact, regenerative biologics have yet to account for the overall personalized profile of an individual to fine-tune therapeutic dose, approach, and effectiveness to not only regenerate the disc but also to delay progression or protect its integrity. The above not only applies to "de novo" degeneration, but it is also relevant to degeneration/disease that may develop adjacent to an operated disc. Such a condition may also necessitate future conservative treatment (eg, physical therapy, medication, injections, etc) or surgery. However, who may be more prone to develop such conditions, how to prevent and manage them, and predict their outcomes is poorly understood. Furthermore, spinal deformities, such as adolescent idiopathic scoliosis, can be life-altering conditions. Who may progress to more severe deformity and additional comorbidities, respond to conservative treatment (eg, bracing) or obtain optimal surgical outcomes continues to

perplex the spine specialist. Preventative measures for such patients continue to remain speculative. Moreover, in general, not all individuals who undergo conservative management for various spine conditions have favorable outcomes. In other words, the "one-size-fits-all" guideline- and protocol-based approach to treating patients with spine-related conditions, is no longer adequate. More precise approaches to identifying the "right" patient for the "right" treatment as well discovering/developing targeted therapies based on more detailed or personalized patient profiling is needed. Understanding with certainty in advance as to who may have a good or bad response to a treatment would be invaluable to all stakeholders.

To combat the massive global burden of LBP and other spine-related conditions, health care systems must develop coherent policies with more "precision-based" management algorithms to maximize proper diagnosis, preventative measures, tailor novel therapeutics, predict outcomes with more certainty (eg, risk assessment, predictive modeling), and overall improve patient outcomes and function. Precision medicine strategies aim to have treatments tailored specifically to the patients' individual needs based on their genetic, immune system status, and overall systemic biomarker omics profile as well as additional phenotype information (eg, imaging, lifestyle) with the goal of improving outcomes and reducing adverse reactions via a wholistic fingerprint and oftentimes big data approach. This may lead to improved quality of life for patients, reduction in noneffective treatments and more cost-effective outcomes, translating into more productive societies.

Prioritization of research and clinical applications in precision spine care can only be achieved via a more precision-based approach fueled by an interdisciplinary platform of clinicians and scientists symbiotically working together to facilitate unprecedented discovery and innovation that can ultimately develop tools to identify the right patients for the most appropriate intervention to obtain the best outcomes while simultaneously decreasing health care costs to all stakeholders for global impact. A precision spine care approach reliant on big data interconnecting numerous platforms of biometrics will be key to realize such aspirations. As such, the onus to move the spine field forward rests on the shoulders of all spine specialists, clinicians, and scientists alike. As a spine community, we need to come together on a large-scale basis to address the platform of precision spine care and its massive potential. It is via collaboration and team work that we can elevate the status quo of the spine discipline to new heights and make an impact that will resonate for generations to come.

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